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ABSTRACT

This paper describes a mathematics and technology program for northern Nevada middle school girls. The purpose of the research is to investigate the impact of an intensive, single-sex, out-of-school program on middle school girls' attitudes and perceived abilities in mathematics and technology. To date the program consists of a one-week, residential summer camp with a full-day fall and spring follow-up session. This paper provides a brief background of the present status of females in mathematics and computer science, and discusses research findings on the impact of the program on knowledge and skill, attitudes, performance and participation, personal and social benefits, motivation and effort, and awareness of college and career opinions. (KHR)

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The Impact of a Summer Mathematics and Technology Program for Middle School Girls

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Running head: MATH & TECH PROGRAM FOR GIRLS

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The Impact of a Summer Mathematics and Technology Program for Middle School Girls

The new millennium has arrived with much work still ahead to help females achieve the knowledge, attitudes, and self-initiative necessary to prepare for the technological future, one that will require sound skills in mathematics and technology. Certainly, the more lucrative occupations require such preparation. A 2000 survey conducted by the American Federation of Teachers demonstrates this fact in its comparison of the average teacher's salary ($41,820) to that of other professionals, such as engineers ($72,427) and computer systems analysts ($66,849). Decades after the onset of strong gender equity efforts, it is still the case that—despite some gains—small percentages of females participate in science- and mathematics-oriented fields.

This paper describes a mathematics and technology program for Northern Nevada middle school girls. To date the program consists of a one-week, residential summer camp with a full-day fall and spring follow-up session. The research reported here relates the impact this program has had upon its participants in three years of operation and the critical program features that have fostered the successful outcomes presented in these data. Both the girls who participated and their parents provide analytical perspectives on the program. I begin with a brief background of the present status of females in mathematics and computer science.

Review of Related Literature

Overall, high school girls in the United States take as many upper-level mathematics classes as boys, with slightly lower enrollment in calculus courses and slightly higher enrollment in other mathematics courses (National Center for Education Statistics [NCES], 2002). However, gender discrepancies appear in mathematics achievement, as well as participation in

postsecondary mathematics and mathematics-related occupations. On the 2000 National Assessment of Educational Progress (NAEP), males attained higher scores than females at the three grade levels tested (fourth, eighth, and twelfth). For both sexes, scores had increased at the fourth- and eighth-grade levels and decreased in the twelfth grade from the most recent previous assessment, which was conducted in 1996. However, only females' scores represented a statistically significant decline in the twelfth grade (NCES, 2001). Males' SAT-M (Scholastic Assessment Test–Mathematics) scores for the 2000-2001 school year topped that of females by 35 points. The scores themselves were hauntingly similar to scores of 30 years earlier, although the point spread has narrowed in comparison with some wider gaps that appeared in the interim (NCES, 2002). Fox and Soller (2001) point out that such performance differences on the SAT-M, which also appear on the GRE (Graduate Record Exam), can be costly for women in terms of college admissions and scholarship decisions.

In 2001 females earned 47% of bachelor's degrees in mathematics, 45% of master's degrees, and 25% of doctoral degrees, reflecting a downward trend in terms of advancement to higher degrees (NCES, 2002). Figures for the computer and information sciences are dramatically lower, with females earning 28% of bachelor's degrees, 33% of master's degrees, and 17% of doctoral degrees (NCES, 2002). The American Association of University Women (AAUW) (1998) has been at the forefront of those who have expressed concern about the low number of women in computer science. The gap, they say, widens from grade eight to grade eleven, and girls are more likely than boys to enroll in clerical and data-entry classes—the modern day equivalent of typing—when they do take computer classes. The AAUW concludes:

> A discouraging new gap is emerging, as computer science becomes the new "boys' club." The failure to include girls in advanced-level computer science courses threatens to make

> women bystanders in the technological 21st century. Some say computer access may one day bridge the educational gap between wealthy and poor students. But little attention has been given to how computer technology is affecting the educational gap between girls and boys. (p. 4)

In the work world, women earn more in professional specialty occupations (e.g., engineers and computer scientists) than in any other occupational category (U.S. Department of Labor, 2001). Gender imbalances appear, however, in specific occupations within the managerial and professional occupational categories. The U.S. Department of Labor (2001) concludes from its 2000 labor statistics:

> In the professional specialty occupational categories, where women earned the most, they were much less likely than men to be employed in some of the highest paying occupations, such as engineers and mathematical and computer scientists. Women were more likely to work in relatively lower paying professional occupations, such as teachers…and registered nurses. (p. 2)

Women comprised, for example, less than 11% of engineers and less than 32% of mathematical and computer scientists, whereas they accounted for more than 74% of teachers and more than 92% of registered nurses. The median weekly earnings for full-time work in these four professions, respectively, was $1104, $992, $711, and $790. Moreover, women workers earned less than men in the same occupations, earning from 81-88% of men's wages or salaries in the four occupations discussed here.

Researchers and educators point to a variety of reasons for females' lower performance and participation in mathematics and computer science in relation to males. Most prominent are females' attitudes and beliefs about these fields, including their perceptions of how gender-

appropriate mathematics and science are for them as females. It is fairly well known, for example, that females experience mathematics anxiety to a greater degree than males (e.g., Levine, 1995). Jones and Smart (1995) consider lack of confidence to be a major factor affecting girls' low participation in mathematics. Similarly, girls have lower self-confidence in their computer ability and a less positive attitude about computers in general (AAUW, 1998). Based on their analysis of NAEP data trends, Bae, Choy, Geddes, Sable, and Snyder (2000) contend, "Achievement gaps appear more closely related to attitudes than to coursetaking" (p. 117). The data show that females are less likely than males to like or to think they were good at mathematics and science. Females' dispositions toward—and hence achievement and participation in—mathematics and technology are believed to be socialized, inculcated by a society that still tends to view these as male domains and which perpetuates the idea that males are naturally more mathematically and technologically inclined (Hanson, 1997).

One recommendation the AAUW (1998) makes on behalf of improving the status of girls in the sciences is for states to make Algebra 1 and geometry mandatory for all students. These mathematics topics are considered to be filters for higher mathematics and science study, as well as for college itself. Jones and Smart (1995) say, "Mathematics is a 'gatekeeper' allowing access to a range of opportunities. Girls are excluding themselves from these opportunities by choosing not to continue with their mathematics studies" (p. 164). The AAUW also challenges educators to develop programs that encourage girls to participate in computer science.

Much interest in single-sex educational settings has appeared in recent years, although some contest the concept on practical, moral, or constitutional grounds. Evidence from a variety of researchers and educators speaks to increased confidence, achievement, or subsequent participation in higher-level coursework for girls in single-sex mathematics and science

classrooms (e.g., Gillibrand, Robinson, Brawn, & Osborn, 1999; Streitmatter, 1997; Wood & Brown, 1997). Participants in Streitmatter's (1997) two-year study of seventh- and eighth-grade girls in all-female mathematics classes were more likely to ask and answer subject-matter-related questions than in coeducational settings. They also reported an enhanced ability to learn the mathematics, an improved view of themselves as mathematicians, and a clear preference for this type of environment. One reason for girls' greater comfort level in this type of classroom may be their expressed concerns about intimidation by boys in mixed-gender mathematics settings, namely, fear of being dubbed smart or fear of asking questions that boys deem "dumb" or otherwise unacceptable (Durost, 1996). Moreover, boys tend to dominate classroom conversation, as well as to be called on in class and be permitted to call out in class more often than girls, and they receive more teacher attention, including more useful feedback (Durost, 1996; Sadker, Sadker, Fox, & Salata, 1993/94). Boys also prefer competitive situations in comparison with girls' propensity for collaborative, small-group ventures (Durost, 1996). Research in coed classrooms shows that boys are likely to monopolize technologies (e.g., graphic calculators or computers) and science lab equipment in mathematics, science, and computer classrooms when they work with girls (Jovanovic & King, 1998; Riggs, 1997).

Numerous out-of-school SMET (science, mathematics, engineering, and technology) programs for girls, such as after-school clubs or summer programs, have had a positive impact on their participants in terms of knowledge acquired and—in particular—favorable attitudes gained (Hammrich, Richardson, & Livingston, 1999; Karp & Niemi, 2000; Mawasha, Lam, Vesalo, Leitch, & Rice, 2001; Morrow & Morrow, 1995; Rohrer & Welsch, 1998; Thompson, 1995). Dobosenski (2001) reports that these types of experiences should begin in elementary or early middle school. Mawasha et al. (2001) conclude that successful programs for women in

SMET disciplines must include the following four components: career-related information and issues; development of SMET content knowledge, acquired experientially; academic and social support that includes peers, parents, teachers, and various professionals (e.g., role models); self-concept and confidence building through effective group work and successful performance in SMET activities. Campbell (1995, p. 232) lists common program elements of several successful SMET programs for girls that she reviewed. She says these programs for encouraging girls:

- use many hands-on activities
- are fun
- are relaxed, with little or no emphasis on individual competition
- build girls' confidence
- provide girls with many opportunities to see that mathematics and science are as readily "girl" fields as boys'
- provide time for questions and an environment that encourages the asking of questions.

Girls' interest in mathematics and science begins to wane at about the middle school level, which is also the juncture at which students make decisions about future course enrollments and career tracks. Therefore, middle school is a critical "make-or-break-it" point for girls in mathematics and science (Campbell, Denes, and Morrison, 2000; Eccles, 1997). The program this paper describes is one attempt to provide a supplementary effort to bolster and extend middle school girls' in-school experiences in these subject areas.

Research Purpose

The purpose of this research was to investigate the impact of an intensive, single-sex, out-of-school program on middle school girls' attitudes and perceived abilities in mathematics and

technology. Specifically, what benefits result from such a program, and which program aspects favorably impact girls' attitudes and abilities most strongly?

Research Method

The Girls Math and Technology Program

The Girls Math and Technology Program targets middle school girls in Northern Nevada. The main program component is a five-day, residential summer camp held at the University of Nevada, Reno. Two full-day follow-up sessions take place on Saturdays in early November and early March. The program began in the summer of 1998 and had run for three years by the time these data were analyzed. Girls were selected randomly from applicants solicited by school mailings to public, private, and Native American schools. The camp began with girls entering grade 7 eligible to attend, with an additional grade level added annually to accommodate return campers. The typical class size is 28 girls who work within their own grade level. Table 1 shows the number of program participants and their grade levels for the three years of this study. Because girls of all academic abilities and backgrounds may apply to the camp, random selection generates a group of girls of mixed ability, socioeconomic status, race/ethnicity, and other personal characteristics. Scholarships are available to participants with demonstrated financial need (about 20% of each year's program participants).

Table 1

Program Participants 1998-2000

	Grade Level(s)	Number of Girls
Year		
1998	7	28
1999	7, 8	56
2000	7, 8, 9	76

Camp topics include problem solving, geometry, spatial skills, data analysis and probability (youngest group only), algebra (older groups only), and more powerful uses of computers, in particular, use of tool software, such as *Geometer's Sketchpad* and *Logo*. These topics are deemed to be particularly important to girls' academic and vocational future. As noted earlier, for example, AAUW (1998) recommends making Algebra 1 and geometry mandatory for all students, and spatial skills have been shown to be significant predictors of girls' mathematics achievement (Tartre & Fennema, 1995). Girls in this program also gain exposure to female role models in mathematics and technology fields by hearing a guest speaker discuss use of mathematics and/or technology in her job, learning biographical information about famous female mathematicians and/or computer scientists in history, and working with an all-female staff. The importance of such role modeling is suggested repeatedly for girls in mathematics and science (e.g., Boland, 1995; Hanson, 1997).

The high-quality[1] staff consists of an even mix of local veteran teachers and upper-division teacher education majors or beginning teachers. Two to four instructors are present in each

[1] Staff names were obtained by cross-referencing recommendations made by the Math Coordinator for the local school district, the President of the Northern Nevada Math Council, and mathematics education faculty at the local university. Instructors chosen to work with the program have a reputation for teaching in the spirit of the *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000), for example, at a conceptual level. Any or all of the following are also true of invited instructors: they continue their own learning in the field (e.g., they have attained or are working on attaining a higher degree in mathematics education); they are active in the field of mathematics education (e.g., they attend conferences, participate in local math councils, or conduct professional development for peers); they have a substantial amount of teaching experience (generally ranging from 8-25 years). Occasionally, a mathematics education college professor also serves as an instructor for this program.

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classroom at all times. Another instructor, who has special expertise in mathematics software, conducts technology segments in the computer lab. In regular class sessions, girls work collaboratively at tables in randomized groups of four. The instructors base their lessons on the Nevada Math Standards established for the grade level the girls will enter in the fall.

Academic sessions are held in the College of Education. Camp participants and overnight staff members take part in recreational activities each evening (such as indoor sports and a movie night), and they stay in university residence halls and eat in the campus cafeteria. Parents are invited to participate in introductory and concluding activities during the summer camp week. Figure 1 shows a sample Thursday schedule for the youngest camper group.

Figure 1

Sample Thursday Schedule for Rising 7th Graders

8:45 a.m.:	Problem solving/reasoning
9:15 a.m.:	Guest speaker on use of math/technology in the workplace
10:00 a.m.:	Data analysis and probability
10:30 a.m.:	Snack break
10:45 a.m.:	Data analysis and probability (continued)
11:45 a.m.:	Spatial reasoning task
12:00 p.m.:	Lunch
1:00 p.m.:	Using geometry software (*Logo*)
2:30 p.m.:	Snack break
2:45 p.m.:	Geometry
4:15 p.m.:	Spare time
5:30 p.m.:	Dinner
6:30 p.m.:	Spare time
8:00 p.m.:	Camper talent show

Note: Printed schedules for program participants include instructor/speaker names for each segment, room locations, and options available for spare-time segments.

Sample

The sample included 121 girls. Of these, 91 had participated in the program for one year, 20 for two years, and 10 for three years. The group was 69% White, 10% American Indian, 7%

Hispanic, 4% Asian, 2% Black, 4% biracial/multiracial, and 4% racially undisclosed Northern Nevada middle school girls of mixed ability, socioeconomic status, and community background (e.g., urban and rural). Additionally, 26 parents were research participants.

Design and Procedures

Four data-gathering measures, one quantitative and three qualitative, were used to address the research questions. (All of these are described in the Instrumentation section.) The Modified Fennema-Sherman Mathematics Attitude Scale was used to gather quantitative information about the girls' attitudes toward mathematics. Program participants completed the instrument at the beginning of the summer camp week, end of the summer camp week, and a fall follow-up session a little more than three months later.

Three qualitative data-gathering methods—personal interviews with the girls and camper and parent questionnaires—were used to determine program impact on participants both in and out of school (in concert with the quantitative data), satisfaction level with and most preferred aspects of the program, and suggested program improvements. Personal interviews were conducted with 30 volunteer first-, second-, and third-year campers on Tuesday, Wednesday, and Thursday of the summer 2000 camp, which ran from Sunday evening to Friday afternoon. The interviews were conducted individually (6 girls), in pairs (2 pairs), or in threes (2 groups), fours (1 group), or fives (2 groups), based on participant choice. A graduate assistant conducted semi-structured interviews using a set of provided questions. (Interviews were semi-structured in that the interviewer asked the given questions but followed some camper responses with requests for clarification or more information.) The sessions were conducted in private settings, such as conference rooms or dorm rooms. They were audiotaped and later transcribed into Microsoft Word for analysis.

Participants who attended the November 2000 follow-up session completed an open-ended questionnaire. Those who did not attend were invited to complete and return the questionnaire by mail. Completed questionnaires totaled 41 of 76 possible respondents for a 54% completion rate. A parent questionnaire was mailed in October 2000, almost three months after the summer camp and about two months after the school year had begun. A second mailing was made in December to those who had not returned the first questionnaire. The completion rate after two mailings was 35% (26 of 75 questionnaires, the reduction in number from 76 recipients resulting from one parent having two daughters in the camp). The questionnaires were intended to solicit evaluative feedback from two perspectives—camper and parent—some time after the main program event. The idea was that a retrospective reflection might yield the most salient program features. Moreover, because program participants had returned to school for at least two months, respondents were able to comment on the impact the program had on participants' school experiences.

Instrumentation

The Modified Fennema-Sherman Mathematics Attitude Scale contains four subscales: personal confidence about the subject matter, usefulness of the subject matter, perception of the subject as a male domain, and perception of teachers' attitudes toward the respondent in the subject. On this instrument, students respond to 47 intermingled positively and negatively phrased statements on a five-point, Likert scale that ranges from "strongly agree" to "strongly disagree." Sample statements follow:

- *Confidence*: I am sure that I can learn math.
- *Usefulness*: Knowing mathematics will help me earn a living.
- *Male domain*: Males are not naturally better than females in math.

- *Teachers' attitudes*: Math teachers have made me feel I have the ability to go on in mathematics.

The highest total score possible on this instrument is 235, with 5 points assigned to the most mathematics- or self-favorable choice on each of the 47 items. The highest score possible for the Confidence, Usefulness, and Teacher's Attitudes subscales is 60 for the 12 items, with a highest score of 55 for the 11 Male Domain items. (The instrument is available at http://www.woodrow.org/teachers/math/gender/08scale.html.)

Interview questions posed to campers consisted of four open-ended questions, two containing subquestions, for example:

- Why did you choose to come to this camp?
- What do you think you are learning? How does it compare with what you have been learning in school?

The camper questionnaire conducted in the fall included six questions that mainly targeted perceptions of the program's impact. Sample questions were, "Do you feel attending the math/technology camp this past summer influenced you in any way in school so far this year?" and "What things do you remember most about the summer math/technology camp?" The parent questionnaire, also conducted in the fall, contained eleven evaluative questions about the program, such as, "What aspects of the camp do you think were most significant to/for your daughter, and why?" and "What aspects of the camp were most important to you as a parent?" (Interview questions and the two questionnaires may be found in Appendices A-C.)

Data Analysis

Scores for the Fennema-Sherman instrument were used only for the first year a participant entered the program, regardless of grade level, so that possible effects of past participation in the

program would not confound results. Means and standard deviations for each subscale were calculated for the three times a first-year camper completed the instrument. The four scores for the first completion point (beginning of the summer camp week) were compared to scores for the same measures for the second completion point (end of the summer camp week) to look for score increases. Scores for like subscale pairs for the first and third completion points (beginning of summer camp week and fall follow-up session) were compared statistically using a paired-samples t-test, testing for significance at the .05 level using a one-tailed test. This analysis included 69 valid pairs of scores. Statistical methods were only used for the four pairs of scores from the first to third testing points because I had greater interest and confidence in the longer-term impact on attitudes.

Qualitative data, which consisted of narrative written or oral responses to questions, were analyzed using the grounded theory approach, "a qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon" (Strauss & Corbin, 1990, p. 24). I used my theoretical sensitivity as a researcher, developed through personal and professional experience, knowledge of the professional literature, and insight gained during the analytic process itself, to interpret and group data by conceptual categories during a line-by-line analysis using open coding. Labeled categories were continually revisited and adjusted during data analysis. Two graduate assistants independently assigned each comment to one or more of the predetermined conceptual categories in order to get a sense of the frequency with which various categories appeared. Due to the limitations of classifying responses by external interpretation, total tallies were viewed in terms of approximations and relative frequencies rather than absolute numbers. Finally, I examined how conceptual categories across the three qualitative data sources compared, the relative frequency

of categorized comments, and how categories might relate to each other (e.g., in terms of causal conditions and consequences). The most salient ideas were integrated into as unified a picture as possible with regard to the stated research purpose.

Results

Results of the analyses are presented in two sections that address the research question, namely, the program's impact on its participants and the critical program elements. Program impact was measured mainly by qualitative data provided by program participants and their parents, with support from quantitative data obtained from the Fennema-Sherman Mathematics Attitude Scale. Critical program elements were determined from the three qualitative data-gathering methods.

Program Impact

Knowledge and skills. The most influential aspect of the Girls Math and Technology Program, as determined by the number of comments program participants and their parents offered, was its impact on the girls' mathematics and technology learning. Both the girls and their parents repeatedly spoke of increased knowledge, understanding, and skills. This aspect of the program ranked highly as the reason the girls had enrolled in the program (as an anticipated benefit), as one of the most important program-related gains after having entered the program, and as a reason for attending the follow-up sessions. Some parents said their daughters had developed a different approach to doing or thinking about mathematics, evidenced in this eighth grader's comment about the camp's impact: "I think of math in a way that I can understand better."

Attitudes. Respondents indicated that the girls had developed greater confidence in their own mathematics and computer abilities, and a better attitude toward these areas of study, as a

result of their participation in the program. A small number of program participants (about 15%) expressed this change. However, parents named it as one of the top two influences the program had had upon their daughter, giving it approximately equal weight with increased mathematics and technology learning. The same two tied as program-induced results of greatest importance to them as parents. Many strong statements, such as those that follow, report increased confidence and its impact:

- I've learned how to be more confident in myself because before I didn't think I knew the answer. I wouldn't even try if I didn't think I was right, but now I just don't care. (camper)
- My daughter said, "Mom, math is my favorite subject in school now. I like math and I'm not afraid to try problems now." (parent)
- My daughter had no desire to attend this camp at the beginning two years ago. She hated math and her grades were poor. She was in danger of failing.... She came back from camp with a new outlook—her attitude was changed. She learned to love math and from that time on has soared. She came home with A+'s and her teacher now continues to push her higher! (parent)
- We believe it gave her self confidence and encouraged her independence. She took the initiative to seek out the counselor and request she be put in the advanced math class. (parents)
- She isn't afraid of math. She had the confidence to take geometry as a freshman at Lakeside High[2] (mostly a sophomore class). She was told by the teacher at registration she might not like it. It might be too hard. She fought to take the class and won. (parent)

[2] Names of individuals and schools are pseudonyms.

Table 2 shows mean Modified Fennema-Sherman Mathematics Attitude Scale scores for three points in time—beginning of summer camp, end of summer camp, and fall follow-up session—for the first year a program participant attended camp. The scores improved across each ensuing test point for each subscale, with one exception: a score in the Usefulness category decreased from the second to the third test, although it still remained higher than the first test score. (Figure 2 displays on a triple bar graph the four subscale scores for the three points in time.) Mean scores from the first to third test were significantly different for the Confidence (t = 2.30, p = .01) and Male Domain (t = 1.85, $p < .05$) categories, with borderline significance for the Teacher's Attitudes category (t = 1.49, p = .07).

Modified Fennema-Sherman Mathematics Attitude Scale Scores
First Camp Year

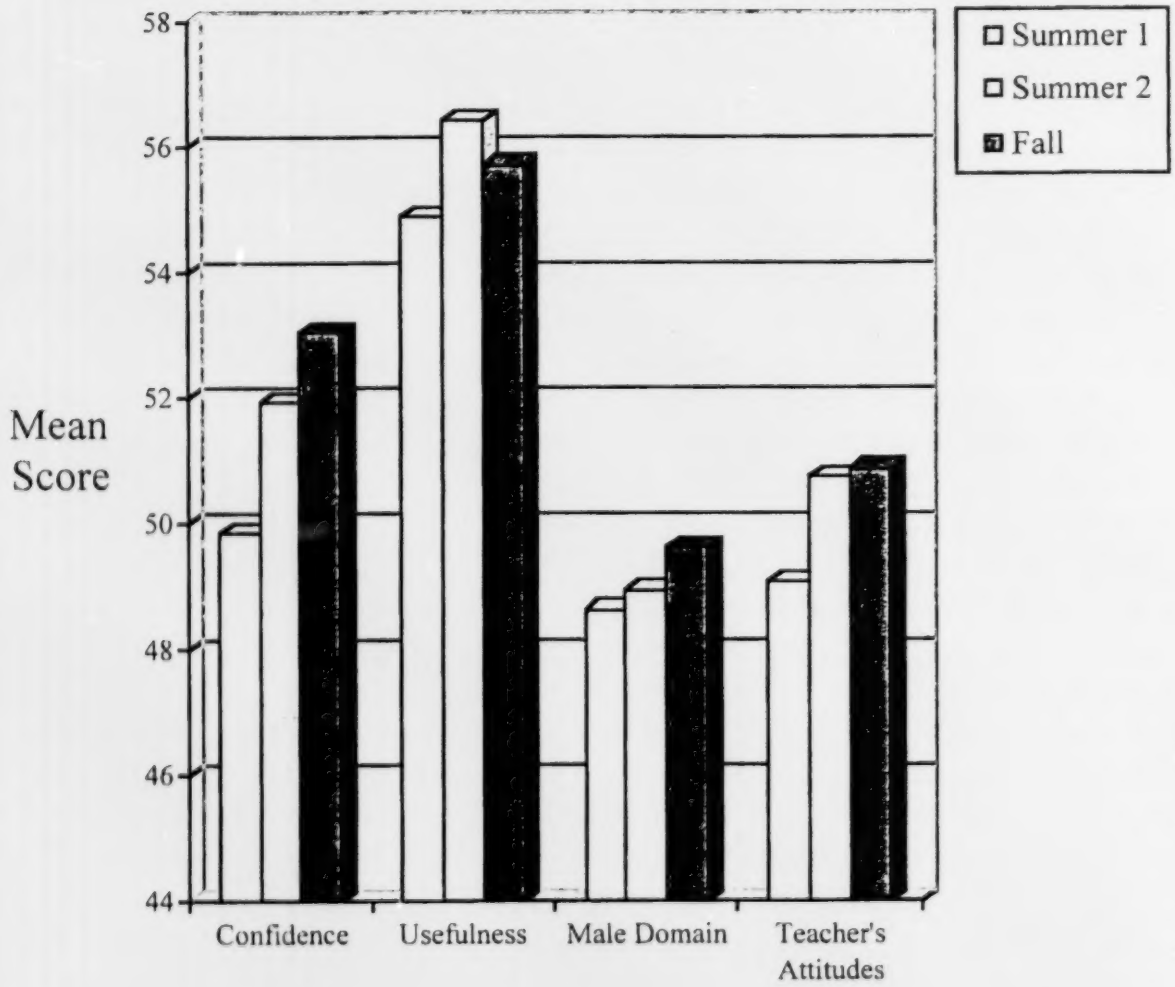

Table 2

Modified Fennema-Sherman Mathematics Attitude Scale Scores First Camp Year

		Confidence		Usefulness		Male Domain		Teacher's Attitudes	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Completion Point									
Summer 1	114	49.86	8.68	54.88	5.78	48.64	4.47	49.09	8.95
Summer 2	115	51.93	8.25	56.42	5.00	48.95	4.64	50.74	9.45
Fall	74	53.04**	8.23	55.70	5.74	49.62*	4.50	50.87	7.94

Note: Summer 1 and Fall scores were compared using a paired-samples t-test using a one-tailed test. This analysis included 69 valid pairs of scores.

*$p < .05$. **$p = .01$

In-school performance and participation. Asked if they believed the program had influenced them in school, 80% of the girls answered yes. Parents made similar assertions. Many respondents' anecdotes attested to benefits related to advanced performance or participation: preparation for and greater success in "this year's math;" placement or self-selection into higher mathematics classes (e.g., early or additional algebra classes), or decisions to take additional mathematics classes or join mathematics clubs or teams; improved grades or test scores. One-fourth of the parents said their daughter had an increased desire to continue learning or taking mathematics as a result of the program. A seventh grader wrote, "I learned stuff that I didn't know in 6th grade. I was behind in math, but now I am ahead," and an eighth grader contended, "Math Camp allowed me to take an algebra (8th grade) class at school this year. I have also joined a math competition team." A parent of a seventh-grade program participant described the camp's impact in the first few months of school thus: "Her attitude about math has changed. Her

grade has gone from an F (last year) to a B, so far. When TerraNova[3] testing, she was excited to share the news: 'We learned about this at math camp, and it was on the test.'"

Out-of-school performance and participation. To a lesser extent, respondents also believed the program had influenced the girls outside of school. In particular, they said the girls had become better at using—and were more likely to use—mathematics in their daily lives, and that they had come to see mathematics to a greater degree as an integral part of everyday life. One parent said of the program's out-of-school impact on her daughter, "She actively plays math games at home," and another said, "I have noticed her understanding of spatial relationships has greatly increased." Two others said their daughters were more likely to do mathematics in their heads, one stating that her daughter was less likely to use a calculator to figure problems.

Personal and social benefits. Parents mentioned several nonacademic benefits they believed their daughters had gained in the 14 weeks that had passed since the summer camp had ended. Benefits reported most often include greater confidence in general (for example, in social settings), improved social and collaboration skills, increased independence and responsibility, and a sense of belonging to a group of girls like themselves. The residential nature of the camp had a strong bearing on many of these comments. "I like the feeling of independence, like being away from home for a while," a rising[4] eighth grader said in a summer-camp interview. Parents were as likely as students to comment on the value of increased independence, responsibility, and exposure to new (nonacademic) things, as the following examples illustrate:

- I think being away from home for a week helped her grow up a little and become more responsible.

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[3] State-mandated standardized test.

[4] Term indicates the grade level a girl would enter in the fall.

- We came from an isolated rural area 100 miles from the closest town.... My daughter needs the exposure in every aspect of this camp.

Motivation and effort. A variety of comments made less often indicate other valuable aspects of the Girls Math and Technology Program. Despite their lower frequency, these comments contribute to an understanding of possible program-related outcomes. One such area is that of the impact on motivation and thus effort. One eighth grader stated simply, "It motivated me in excelling in math." A rising eighth-grade interviewee at the summer camp shared her increased motivation to learn mathematics, based on a newfound awareness of its utility: "I would always sort of dose [*sic*] off in my math class, but now that I know that I'm going to use it later on, I'll pay attention." Comments noted earlier about pursuing higher or additional mathematics also support increased motivation as an identifiable program outcome in the respondents' eyes. A small number of girls made motivation-related comments that reflected—for example—greater incentive to do assigned homework, study during the summer, or seek out mathematics problems to solve on their own time. Parents spoke of daughters having increased interest and activity in doing mathematical tasks in and out of school, working harder at mathematics, setting higher educational goals than before the camp, and considering mathematics-related occupations for their future.

Assistance to others. Another outcome some program participants and their parents verbalized, particularly in reference to things the girls planned to do, was to help others with their new knowledge and skills. They most often mentioned assisting other students, but they also named teachers and even parents. One mother wrote regarding her daughter's response to the program, "She helps her father with his problem solving. He counts on her to help him with his livestock. She helps other students to learn the math." In an interview, an eighth grader talked

about having learned to use graphic calculators: "I know how to use those, so when I start with those I'll be like, yeah, you do this and I can tell all my class how to use it." Similarly, a parent verbally relayed at a follow-up session the fact that teachers at her daughter's school had recently received *Geometer's Sketchpad* but did not know how to use it. Her daughter, who had learned to use the software at the summer camp, offered to teach them.

Awareness of college and career options. Some parents addressed the fact that their daughters had gained awareness of what college is like or expressed interest in attending college. One parent wrote, "She now has an idea (a positive one) of what college will be like." A few parents said their daughters had returned from the summer camp with new or expanded interest in or awareness of future career options. One said, "Right after her camp she talked about how math is in every occupation. My daughter started talking more about her future and careers."

Perhaps a final testament to the program's impact is the fact that 80% of the participants said they planned to return to the summer camp the following year. The main reason the others did not assert the same was uncertainty about their summer plans in terms of family vacations or sports camps.

Critical Program Elements

Academic content. One vitally important program element, as the previous discussion indicates, is the type, amount, and quality of academic content. Respondents frequently described the mathematics and technology topics as ones the girls found interesting or challenging, or ones to which the girls had had little exposure or had encountered the following school year in a more prepared manner. Note, however, that the only criticism (other than non-air conditioned dorms!) that a few individuals expressed was lack of challenge or new material. This dilemma resulted

from the difficulties of teaching girls with a wide range of abilities from across a large, varied geographical region.

Instructional approach. Another highly recognized program element—in terms of its successful impact—was an instructional approach that included group work and hands-on learning in a welcoming, reasoning-oriented environment. This resonates with research indicating that girls fare better in learning situations that are more cooperative and hands-on than often is true of the traditional mathematics class (Fox & Soller, 2001). The classroom climate strongly impacted the girls and their parents in this program, both of whom noted the importance of the more relaxed, supportive atmosphere. A rising eighth grader said in an interview, "I know I can relax in class and just watch and learn more comfortably instead of just going all tensed up." The girls also pointed out that these methods of instruction not only differed from those used in their schools, but they also better suited the girls' learning styles. A parent said her daughter enjoyed being taught in a different style by women. She felt "the information was presented in a way that was understandable." The girls and their parents also expressed appreciation for the greater degree of individual attention afforded by having 2 to 4 staff members present for each group of 28 girls in the instructional sessions.

Single-sex setting. A program element mentioned frequently during the personal interviews was the single-sex environment. A few parents also referred to the comfort level such a setting afforded their daughter. The girls, particularly the rising ninth graders, supported the single-sex setting strongly and gave reasons for this preference. The comments were unprompted in that they were raised in response to an open-ended solicitation of what they liked about the summer camp, which they were attending at the time of the interviews. Sample comments follow:

- It's a better learning environment than my school, because mostly the teachers call [on] the guys before they call [on] the girls.
- In class boys shout and they think they know everything, and when they're wrong they just go, "Okay, whatever," or they don't ever give a girl a chance to answer, so all the girls are just sitting there going, "Okay, fine." [peer follow-up] But a lot of the popular [girls], they'll be sitting there flirting with all the guys and they won't be paying attention, but here you have no one to flirt with. [peer follow-up] Yeah, so then you don't have distractions.
- All the other camps I've gone to are co-ed, and the guys and girls were always fighting and more concentrating on each other. But here with just the girls, I mean, we have fun and we are ourselves and we just do math.
- You're not embarrassed when you say an answer and it's wrong.... You don't have to be talking to a guy and acting real shy and stuff like that. You can express yourself.... It'll help me not be shy in class. I mean, there are more guys than girls in our classroom and you get kinda hesitant to ask questions, and when I do, it feels like the guys are snickering at me.

High-quality staff. Another highly regarded aspect of the program is the staff. Both program participants and their parents appreciated the staff's mathematical/technological competence and the supportive, accepting, and inviting manner in which they interacted with the girls. A parent said the staff's "positive and enthusiastic attitude greatly encouraged my child." Respondents appreciated the low-pressure atmosphere, immediacy of help and responses to questions, individual attention, and staff approachability. A rising eighth grader said, "They do a lot more explaining here. I understand it a lot quicker than I do in school." A peer followed with, "Here

we do a lot of hands-on stuff…but at school they teach you one way and basically you have to do it that way." A rising ninth grader provided her perspective on another aspect of the staff's teaching technique:

> They'll walk up to you and say, "What do you think the answer is?" When you give them an answer, they say, "Can you find a different way to answer it?"…They're giving you a second option on how to learn, not just one option—do it by the book.

Role models. Respondents also valued the modeling aspect of the camp, in terms of the all-female staff and guest speaker, as well as the biographical information about famous female mathematicians in history. A rising ninth grader described her preconceived notions before arriving at the summer camp: "I thought I would come here and…be stuck with all these nerdy people with glasses," to which a peer added "that concentrate on math because they don't have a life." Another girl of the same age said in another interview, "It kind of showed me that being smart and good at a subject is okay, and there are other girls who will concentrate just as much at math as they would other subjects." Parents also had concerns about prior stereotypes their daughters may have absorbed about females in mathematics fields. One expressed the importance of "positive role models being female and involved in areas of study Jenny may not have attributed to females" and another of seeing staff members as "real, human people who can have fun."

Social and recreational time. Apart from academics, the girls and their parents strongly lauded the social and recreational aspects of the summer camp. A parent wrote, "I think the mix of school and recreation was a good lesson in 'balancing' your life." The camp schedule included recreational activities each evening. Other social time occurred during meals and structured, late-afternoon or early-evening spare time. One girl said, "I like how you can go on breaks after hard

work. You get to do something [a recreational activity]." Respondents often mentioned "making new friends" as a major draw of the program. A rising ninth-grade interviewee said, "There are people from different places and I'm, like, what's it like there? And they tell me. I get to know people that I don't know and have never known before." The girls also enjoyed the opportunity to spend time on a college campus, and to live in the dorms and eat in the college cafeteria. Not only the social experience of eating in the cafeteria, but also the type and amount of food was important to the girls, who raised the topic fairly often in interviews and on questionnaires. Some contended the food and breaks, including 15-minute mid-morning and mid-afternoon snack breaks, helped them work better.

Continued contact. Although attendance at the two Saturday follow-up sessions typically fell a little below 50% due to travel distances and other personal or family commitments, program participants and their parents found them important. Both groups named the same two top reasons: the learning opportunity (review and new material) and seeing friends and staff members.

Discussion

Score increases on the Fennema-Sherman Mathematics Attitude Scale from the beginning to the end of the summer camp week probably are not very useful. End-of-week scores may be unrealistically high due to temporary "of-the-moment" reactions compared with stable attitudinal changes over time. However, improved scores from the camp beginning to the first follow-up session three months later, combined with participant and parent comments, support the finding that the Girls Math and Technology Program positively impacted participants' self-confidence in mathematics and their perceptions of mathematics as an appropriate domain for females, as well as other likely areas, such as mathematics knowledge and skills. Comments offered on data-

collection forms and in interviews provide evidence that the same may be true for technology, although its less prominent status in this program made it less likely to be discussed in responses to open-ended questions. Participant and parent comments suggest that the girls showed improved performance in school mathematics and pursued mathematics to a greater and more proactive degree both in and out of school. The girls seemed to learn mathematics and technology content and skills that they applied in later schooling. However, it is likely that the program most strongly impacted the girls' attitude toward those subjects, toward their own mathematics capabilities, and toward the role of females in mathematics. In particular, increased confidence, motivation, and awareness may have in themselves influenced the girls' school performance.

Attitudinal changes may be the most important areas to target in a relatively short, intensive program such as this. Positive attitudes may wield a greater influence over a girl's schooling than the amount of mathematics and technology learning that can take place in a week. Increased self-confidence and a belief in the importance of mathematics and technology for their own future may, for example, lead program participants to seek additional learning experiences in mathematics and technology. Several girls in this study, for example, mentioned that the program had led them to enroll in higher mathematics classes or mathematics clubs/teams, or that they played mathematics games more often at home. However, the importance of sustained support in relation to attitude changes certainly merits investigation.

The residential nature of the summer camp appears to be a critically important aspect of the program. For one thing, it allows rural girls—a group of whom drive seven hours from a remote Native American reservation—to participate. Much support and networking occurs during the nonacademic portions of the camp. Girls bond with each other and with the staff during these

times, and they see that girls and women who like mathematics are "normal" people with many interests and abilities and a capacity for having fun beyond their academic pursuits. The social and recreational aspects of the camp were invaluable in these respects. The overnight feature of the camp yielded other benefits as well, such as increased independence and responsibility, which are important personal skills to possess in both academic and nonacademic settings.

Another strong success factor in this program is the staff. Instructors are chosen carefully from among the best local female mathematics teachers (or prospective teachers). A program such as this may seek and use the services of only the most highly qualified teachers, a luxury individual schools typically do not have. The instructors used excellent teaching techniques currently promoted by the mathematics education community at large, methods that seemed to suit girls' learning styles quite well. Of course, learning mathematics without homework or the pressure of earning grades reduced some anxiety students typically feel related to their mathematics schooling. Another unique benefit not afforded to common classrooms is a lower student-to-teacher ratio, with 2 to 4 instructors per 28 girls. This arrangement allows for more individual attention, which both the girls and their parents noticed.

Program participants addressed—unprompted—and appreciated the single-sex nature of the program and articulated important reasons why this benefited them in terms of their learning and learning environment. These comments arose mainly in interview situations. This may speak to the importance of using varied assessment measures for any program, or it may be that this feature of the program was more prominent while the girls were in the midst of active participation in the summer camp, rather than relying on recollections several months later. It may also be that these responses were more likely to be triggered by the interview question that asked the girls to compare camp instruction to their own schools, whereas no such item was

included on the questionnaire. A few parents also indicated that the single-sex environment aided their daughters' learning. Moreover, they said that the role model aspect created by female instructors, a female guest speaker, and information about famous female mathematicians in history helped the girls better see themselves as legitimate doers of mathematics in the present and in future careers.

Closing Comments

These and other research data indicate that a single-sex environment—at least for an academically supplemental program such as this—positively impacts girls' attitudes and performance. At the least, some girls and parents seem to believe this is so. Many researchers and educators recommend single-sex environments for girls' education, particularly in subject areas such as mathematics in which societal stereotypes may cause females to be marginalized. The program described in this paper allows for girls to learn mathematics and technology in such an environment while they participate fully in their regular coed school studies. It provides auxiliary support for their in-school learning. This type of program is often recommended for girls in the sciences. Hanson (1997), for example, recommends offering out-of-school technology programs and no-pressure opportunities for girls to use computers, as well as providing female role models and career options in technology, particularly at the middle school level.

Most likely, the girls would have reaped some of the benefits reported in this paper if the program had been coed. However, these data and informal impressions indicate that the comfort level of the all-female setting, as well as the role modeling aspect, instructional styles that may have suited girls particularly well, and greater opportunities for participation, probably resulted in more extensive gains than the girls would have attained otherwise.

Future planning for this program will involve making decisions about appropriate ways to address the broad range of abilities present in each grade-level grouping, which exceeds that of the typical classroom because of the vast region from which the program draws its participants. The program staff also plans to seek ways to continue connections with the participants to a greater degree across the year, most likely in the form of a web site that includes an electronic bulletin board, and to explore ways to recruit and use the services of community volunteers.

The data provided in this paper show that a well-planned program that targets girls in mathematics and technology can have a positive impact on girls' attitude and performance in these areas both in and out of school. Furthermore, it is likely that the effects are more extensive than research measures can gauge. It would be difficult to determine, for example, how seeds planted in this event might grow beyond the direct reaches of this program, in terms of how the participants direct their own future and influence that of others.

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Appendix A

Camper Interview Questions (during July summer camp)

1. Why did you choose to come to this camp?
2. What did you hope to gain by attending?
3. What do you think you are learning? How does it compare with what you have been learning in school?
4. What other things do you like about being here? Are there some things you don't like or which could be improved?

Appendix B

Camper Questionnaire (early November after summer camp)

1. Do you feel attending the math/technology camp this past summer influenced you in any way in school so far this year? If so, in what ways? If not, why not?
   Did it influence you in any way out of school? If so, in what ways?
3. What things do you remember most about the summer math/technology camp?
3. Have you kept in touch with anyone from the summer camp that you had not known before attending? If so, how often?
4. Do you plan to attend this summer's math/technology camp? Why or why not?
5. For what reasons did you attend ["not attend" for absentees] today's follow-up session?
6. Do you have any concerns about math or technology either in or out of school? If so, what are they?

Appendix C

Parent Questionnaire (late October after summer camp)

Aspects of the camp to consider in responding to questions:

- Content: problem solving; probability/statistics (younger campers); algebra (older campers); geometry/spatial skills; computer work; information about historical and contemporary women in mathematics
- Instruction (teaching methods, organizational details for instruction, etc.)
- Staff
- Guest speakers
- Parent involvement segments
- Food and lodging
- Recreation
- Camp structure (e.g., summer week with two follow-up sessions)

1. Why did your daughter choose to attend this camp? (What were her initial reasons?) Include any part you played in this decision-making.
2. To what degree do you think your daughter enjoyed the camp? What leads you to believe this?
3. Do you feel attending the camp this past summer influenced your daughter in any way <u>in school</u> so far this year? If so, in what ways? If not, why not?
   Do you think it influenced her in any way <u>out of school</u>? If so, in what ways?
4. What aspects of the camp do you think were most significant to/for your daughter, and why?
5. Of what value do you find the two full-day Saturday follow-up sessions across the following school year?
6. What aspects of the camp were most important to you as a parent?
7. Do you think your daughter has any concerns about math or technology either in or out of school? If so, what are they, and what do you think might cause them?
8. If your schedule permitted and the camp were held again for your daughter's age group, do you think your daughter would return next summer? Why or why not?
9. Do you have any other <u>positive feedback</u> regarding the camp components listed at the beginning of this form (or others not listed)?
10. Do you have any <u>suggestions or constructive criticism</u> regarding the camp components listed at the beginning of this form (or others not listed)?
11. Please provide any other feedback you think might be useful that was not requested above. (Again, any of your daughter's comments or actions related to the camp that you recall hearing or observing will be helpful.)

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